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AUTHOR McInerney, Valentina; And Others
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ABSTRACT

This paper reports on a study designed to examine the comparative efficacy of collaborative self-regulated learning and direct teaching on the reduction of computer anxiety among students, as well as the comparative effects of these models of teaching on student achievement. Using a quasi-experimental design, two equivalent groups of university students completing computer coursework were given alternative modes of delivery of an introductory computing course. One group received "training" through direct teaching, and the other group received "training" through direct teaching plus collaborative self-regulated learning facilitated by the instructor. Results suggest that the group receiving "training" by direct teaching was less anxious at the conclusion of the subject than those receiving "training" through a combination of direct teaching and collaborative self-learning on three scales: gaining initial computer skills, competence with computers, and receiving feedback on computer competence. There were no interaction effects on these scales, and no significant differences by group were found on any of the other scales. There was no significant difference between the two groups on achievement level. (Contains 23 references.) (Author)

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Valentina McInerney
Dennis M McInerney
Robyn Lawson
Lawrence Roche

University of Western Sydney, Macarthur

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Abstract

This paper reports on a study designed to examine the comparative efficacy of collaborative self-regulated learning and direct teaching on the reduction of computer anxiety among students, as well as the comparative effects of these models of teaching on student achievement.

Using a quasi-experimental design two equivalent groups of students completing computer coursework were given alternative modes of delivery of an introductory computing course. One group received "training" through direct teaching, and the other group received "training" through direct teaching plus collaborative self-regulated learning facilitated by the instructor.

Results suggest that the group receiving the "training" by direct teaching was less anxious at the conclusion of the subject than those receiving "training" through a combination of direct teaching and collaborative self-regulated learning on three scales: gaining initial computing skills, competence with computers and receiving feedback on computer competence. There were no interaction effects on these scales. There were no significant differences by group on any of the other scales. There was no significance difference between the two groups on achievement level.

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Recent research has demonstrated that computer anxiety is an important predictor of student achievement in computing skills. For example, Marcoulides (1988) concluded that computer anxiety significantly influences the degree to which computers can be utilized effectively by tertiary students and that although computer experience does diminish the anxiety to some extent, varying degrees of computer anxiety remain. Furthermore, the higher the initial level of computer anxiety, the lower the computer achievement. In developing a standardized test of computer anxiety (Computer Anxiety Index - CAIN), Simonson, Montag-Torardi and Whitaker (1987) demonstrated that students with higher computer anxiety scores had lower scores on an achievement test of computer literacy.

Many computer education courses offered at tertiary institutions throughout Australia either ignore the issue of student anxiety, or are based on the belief that gaining experience with computers (throughout a course) will reduce computer anxiety. The controversy regarding the effects of computer experience on student anxiety and achievement, as cited above, cause the present authors to question the wisdom of ignoring the impact of computer contact on student anxiety, or presuming that such contact, *per se*, will alleviate anxiety.

In an earlier study (McInerney, McInerney & Sinclair, 1994) the authors sought to examine the effects of "forced" computing experience, such as compulsory computing courses required during teacher training, on the computer anxiety of first year teacher education students. This type of experience is distinct from voluntary computer interaction which would be predicted to cause little anxiety.

The evidence from this study gave some support to previous findings that explain computer anxiety from a social learning perspective. Personal ownership of computers, familiarity with a variety of computer applications and completing a compulsory word processing course all reduced anxiety for first year teacher trainees.

A simplistic explanation, however, that increased computer experience alone would reduce computer anxiety did not account for the complex interactions between the individual and situational variables found in this study: a number of students still remained anxious at the end of the Educational Computing course. Clearly, for some individuals, increased computer experience did not necessarily alleviate anxiety, especially when such experience formed part of formal tertiary coursework.

Within any group of students interacting with computers there may be those who suffer from a debilitating form of anxiety that is clinical. It is the severely and moderately anxious students that need to be identified so that remediation appropriate to their specific area of anxiety can be designed, and their performance maximised. Research into the types of computer training for students that best prevent initial anxiety from escalating, perhaps by focussing on building confidence and a sense of personal control in a non-threatening learning environment, individualised if necessary, was urgently needed. It was in this context that the following study was designed.

In keeping with the **constructivist philosophy** of learning, there has been considerable educational interest over the last decade in the phenomenon of student

self-regulated learning as a desirable product of education processes. From a social cognitive perspective self-regulated learners direct their learning processes and attainments by setting challenging goals for themselves; applying appropriate strategies to achieve their goals; and enlisting self-regulative influences that motivate and guide their efforts. Self regulated learners exhibit a high sense of efficacy in their capabilities, which influences the knowledge and goals they set for themselves and their commitment to fulfill these challenges. This conception of self-regulated learning not only encompasses the cognitive skills emphasized by metacognitive theorists, but also extends beyond to include the self-regulation of motivation, the learning environment, and social supports for self-directedness (Bandura, 1986; Corno, 1992; Hayes et al, 1985; Paris & Oka, 1986; Schunk, 1990; 1991; Zimmerman, 1990). Research has shown that self-regulation is a skill which can be learned, and that students can develop the will or motivation to be self-regulated by realizing that they are responsible and capable of their self-development and self-determination (McCombs & Marzano, 1990).

This awareness of the self as agent of learning (or personal agency for learning) is gained through the process of **metacognition** (understanding one's own part in one's learning) and produces in the learner a sense of self-efficacy which enhances the experience of competency.

Previous research in the areas of self-regulated and cooperative learning has demonstrated the power of these approaches in reducing anxiety about mastery, raising self-esteem, and enhancing achievement. These philosophies, therefore, underpin the present research.

Our research therefore examined the question of the most effective mode of instruction for assisting undergraduate students in gaining initial computing skills by contrasting a traditional direct teaching approach with an approach which emphasised the development of self-regulation through cooperative group work.

The hypotheses examined were that computer anxiety will be significantly reduced, and that computer competence (both actual and perceived) will be significantly increased as a function of undergraduate students engaging in cooperative self-regulated learning of computing skills.

Specifically, during this study we:

1. Conducted quasi-experimental research using two equivalent classes in the subject Introduction to Computers. One class was taught using direct instruction. The other class was taught using a program based upon Direct Instruction plus collaborative self-regulated learning. **The content covered in each class was equivalent, and assessment modes were the same.**
2. Measured anxiety scores and levels of student achievement at the conclusion of the instruction, and related these to modes of treatment.
3. Observed, described and evaluated the program in operation using qualitative observational techniques (regular interviews with lecturer and selected high and low computer anxious students, as well as monitoring of student and lecturer logbooks).
4. Selected four high-anxious students and four low-anxious students (two from each group) for close observation through case-work study methodology to give the research depth and verisimilitude.

This paper reports on parts one and two of the study.

Methodology

The research reported in this paper was designed to examine the comparative efficacy of two modes of teaching (Direct Instruction alone and Direct Instruction plus Collaborative Self-Regulated Learning) on the reduction of computer anxiety among students. It was also designed to examine the comparative effects of these two teaching models on student acquisition of computing competencies.

Sample

Two equivalent groups of students completing compulsory computer coursework in the subject Introduction to Computers were randomly assigned to alternative modes of delivery taught by the same instructor. The classes were selected from the Faculty of Arts and Social Sciences at a regional university in NSW, Australia. One group ($n=16$, $m=10$, $f=6$) received computer "training" through direct instruction, and the other group ($n=15$, $m=7$, $f=8$) received "training" through direct instruction and the development of collaborative self-regulated learning strategies. The average age of the students was 20 years.

Pretest/posttest questionnaire instruments were administered to elicit information regarding base levels of computing competence (e.g., KeyCoach), and computer anxiety levels using the validated McInerney and McInerney Computer Anxiety and Learning Measure CALM (McInerney, McInerney & Roche 1994).

Treatment

The **direct instruction model** has traditionally been adopted for skills training such as in computing. Research in the area of direct instruction (or explicit teaching) has identified the following teaching functions of this model: present new material, provide guided and independent practice, and review regularly to consolidate learning (Rosenshine). Such teacher-directed instruction formed the basis of one treatment received by students.

Self-regulated learning has been conceptualised as having three major components: student metacognitive strategies for planning, monitoring, and modifying their own learning; student management and control of their effort in learning, and student cognitive strategies used to learn, remember, and understand new material such as organisation, rehearsal and elaboration (Pintrich & DeGroot, 1990). These aspects were included in the research design.

Last, the **Cooperative learning** structure implemented met the following criteria as outlined by Johnson & Johnson, (1991): positive independence, face to face interaction, individual accountability, collaborative skills and group processing.

Variables

Independent variables of interest were: a). treatment; b). level of experience, and c). gender. The latter two variables were included to examine any potential interaction effects that might mediate the effect of the treatment

Dependent variables of interest were: a). levels of anxiety as measured by the following CALM scales: gaining initial computing skills; competence with computers; handling computer equipment; receiving feedback on computer competence; learning about computers; positive sense of control; negative sense of control; computer self concept; positive view of self; negative view of self; state anxiety in computing situations; worry state; distractability; physiological symptoms;

and happiness state; and b). performance outcomes - computer competence as assessed by the indicators appropriate to the subject (assessment items).

Hypotheses:

1. There will be no significant difference in computer anxiety between students taught using direct instruction and those whose skills are developed through direct instruction plus collaborative self-regulated learning strategies.
2. There will be no significant difference in the acquisition of computing skills between students taught using direct instruction and those whose skills are developed through direct instruction plus collaborative self-regulated learning strategies.

Results and discussion

Preliminary analyses were conducted to ascertain whether the two groups were equivalent on prior experience and ability, as well as on initial levels of anxiety. Using a prepared survey form students were asked to self-report their level of competence with DOS, wordprocessing, database and spreadsheet applications. Oneway analyses of variance indicated that there was no significant difference between groups on prior levels of competence on each of these measures. Oneway analyses of variance on the dependent anxiety scales (CALM scales) also indicated that there were no significant differences between treatment groups on any of the scales prior to the commencement of the treatment.

Posttest computer anxiety

Analyses of covariance using the pretest CALM scales as covariates were conducted on the posttest CALM scales to test the first hypothesis. Significant main effects were found for the treatment variable on only three of the scales: Learning about the Basic Functions of Computers ($F=7.946$, $df=1/13$, $p=.014$), Competence with Computers ($F=7.355$, $df=1/13$, $p=.018$), and Receiving Feedback on Computer Skills ($F=7.597$, $df=1/13$, $p=.016$). There were no interactions with sex or declared level of experience. In each of these cases, the group receiving the direct instruction treatment were significantly less anxious on these three scales at the completion of the study than those undertaking the direct instruction plus collaborative self-regulated group work. However, the mean differences were small and in the low anxiety range. Consequently, across the full set of CALM scales, there is no reason to reject the null hypothesis for this sample.

This result ran counter to what we expected. Reasons that could be given to explain the results include the relatively small sample size and the relatively low levels of anxiety registered by the CALM at posttest. More importantly, it is possible that the treatments were differentially salient to high anxious students. In other words, it is possible that the high anxious students within the direct teaching treatment benefitted from the structured approach, while the high anxious students in the collaborative self-regulated group treatment were less adaptable to the less structured approach. Furthermore, it is more than likely that the low anxious students remained low anxious at the end of the subject irrespective of treatment. The appropriate way to test this hypothesis is through an aptitude treatment interaction analysis. In a follow-up analysis we will form a grouping variable based on two levels of anxiety of students at pretest (low and high anxiety) and repeat the ANCOVAs with this as an independent variable. In this case it will be possible to assess whether there is an interaction between treatment and level of anxiety (low and high).

An alternative explanation discussed in further detail in McInerney, McInerney, Lawson and Roche (1994) concerns the retention of subjects within the direct teaching treatment. At the conclusion of the study the two groups were no longer equivalent as it appears that within the direct instruction sample a number of the high anxious students resigned from the subject. Hence it is plausible that the mean score on anxiety and achievement for this group is more positive than it would have been had these students remained in the subject. In this event the direct instruction approach could be seen as having deleterious effect on anxiety and achievement levels of high anxious students. A means of investigating this is to reanalyse the data using a matched sample approach using data from the students who completed the subject in both treatments. These analyses will be conducted at a later date.

Computer competence

Final assessment results for both groups indicate that there were no achievement differences between the groups (mean=21.6, $sd=3.1$ and mean=21, $sd=2.3$ respectively). Again, this ran counter to expectations. However, this finding is important as it suggests that students who are taught in a less structured, student centered learning environment, where the emphasis is on collaborative self-regulated learning, achieve at least as well as those students receiving more structured teacher guidance. Indeed, as mentioned above, if both groups had been intact at posttest the achievement levels for the collaborative self-regulated group may have been higher than for the direct instruction group.

The implications of this finding for the presentation of introductory computing courses are important. First, it would appear that the role of the teacher can be redefined as a facilitator of group interaction without any decrement in student performance. This may be particularly important in circumstances where highly qualified computer instructors are not available. Second, the academic, affective and social benefits (such as critical thinking, problem solving, positive attitudes and positive interpersonal relationships) obtained through collaborative self-regulated learning may be important additional bonuses to students taught through such an approach. We address these potential benefits in our discussion of the qualitative data in McInerney, McInerney, Lawson & Jacka (1994).

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